Investigating Le Chatelier's Principle

Topical Unit of Instruction: Equilibrium

Teacher's Edition

Rehab the LAB

Introduction

This is the classic $FeSCN^{2+}$ equilibrium activity. Instead of using several milliliters of chemicals, students use drops of mostly dilute solutions.

Time

50 minutes or less

Objectives

1. To observe equilibrium shifts as stresses are applied to a chemical system.
2. To use Le Chatelier's principle to explain equilibrium shifts in a chemical system.

Preparation

To make 100 mL of each chemical use:

0.2 M $FeCl_3$: 5.40 g of $FeCl_3 \cdot 6\ H_2O$
0.2 M KSCN: 1.94 g of KSCN
0.2 M $Fe(NO_3)_3$: 8.08 g of $Fe(NO_3)_3 \cdot 9\ H_2O$
0.2 M KCl: 1.48 g of KCl
6.0 M NaOH: 24.00 g of NaOH

Fill 100 mL volumetric flasks about ¾ full of distilled H_2O. Add appropriate amount of chemical. Swirl to dissolve. This may take several minutes for the iron compounds. Dilute to volume and divide among labeled dropper bottles. NOTE: Dissolving NaOH is very exothermic. Allow to come to room temperature before diluting to volume.

Materials

(For a class of 32 students working in pairs)

- 4 sets of dropper bottles of:
  - 0.2 M $FeCl_3$
  - 0.2 M KSCN
  - 0.2 M $Fe(NO_3)_3$
  - 0.2 M KCl
  - 6.0 M NaOH
- several liters distilled H_2O
- 16-250 mL beakers
- 80 test tubes (13 X 100 mm work well)
- 16 test tube racks
- wax pencils

Typical Results

Chemical Added	Observations / Description	Stress Ion	Spectator Ion	Direction of Equilibrium Shift
B: $Fe(NO_3)_3$	darker orange	Fe^{3+}	NO_3^-	→
C: KCl	no change	none	K^+ and Cl^-	no shift
D: KSCN	darker orange	SCN^-	K^+	→
E: NaOH	pale yellow haziness	OH^-	Na^+	←

Typical Results

When NaOH is added, OH- reacts with Fe^{3+} to form insoluble $Fe(OH)_3$ which precipitates out of solution to cause the haziness. In essence, adding OH^- as a stress decreases the amount of Fe^{3+} in test tube E. This decreases $FeSCN^{2+}$ causing the equilibrium to shift left producing more colorless SCN^-. Hence, the color becomes pale.

Disposal

1. Contents of test tubes A,B,C, and D can be poured down the drain with lots of H_2O.
2. Have students pour contents of test tube E in a large beaker. Neutralize with acid to a pH between 6 and 9, and pour down sink with lots of H_2O.

Hints

You may want to add the 6.0 M NaOH to test tube E for each pair of students. This will help minimize drips of this dangerous, caustic chemical on counter tops and outside of test tubes. Students may need help recognizing the haziness after the NaOH is added.

This lesson produced by the Local Hazardous Waste Management Program in King County, Washington. For more information, e-mail haz.waste@metrokc.gov or call (206) 263-3090.